GEOS-5: Update and Plans

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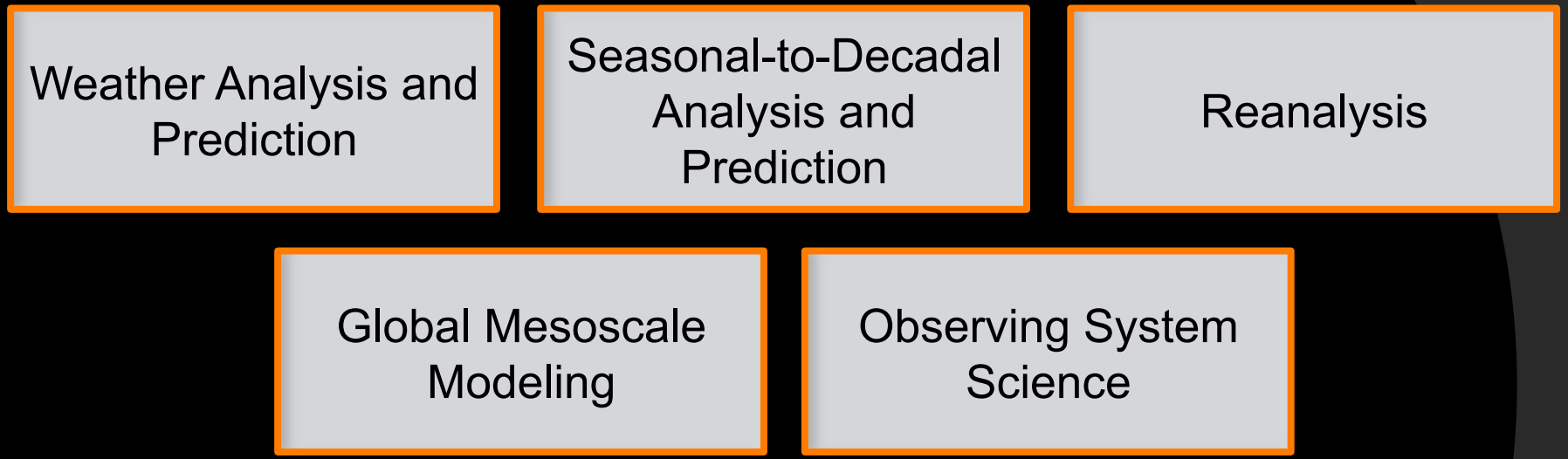
Overview

- Scope of the GMAO's work
- A few examples
- Support for CERES

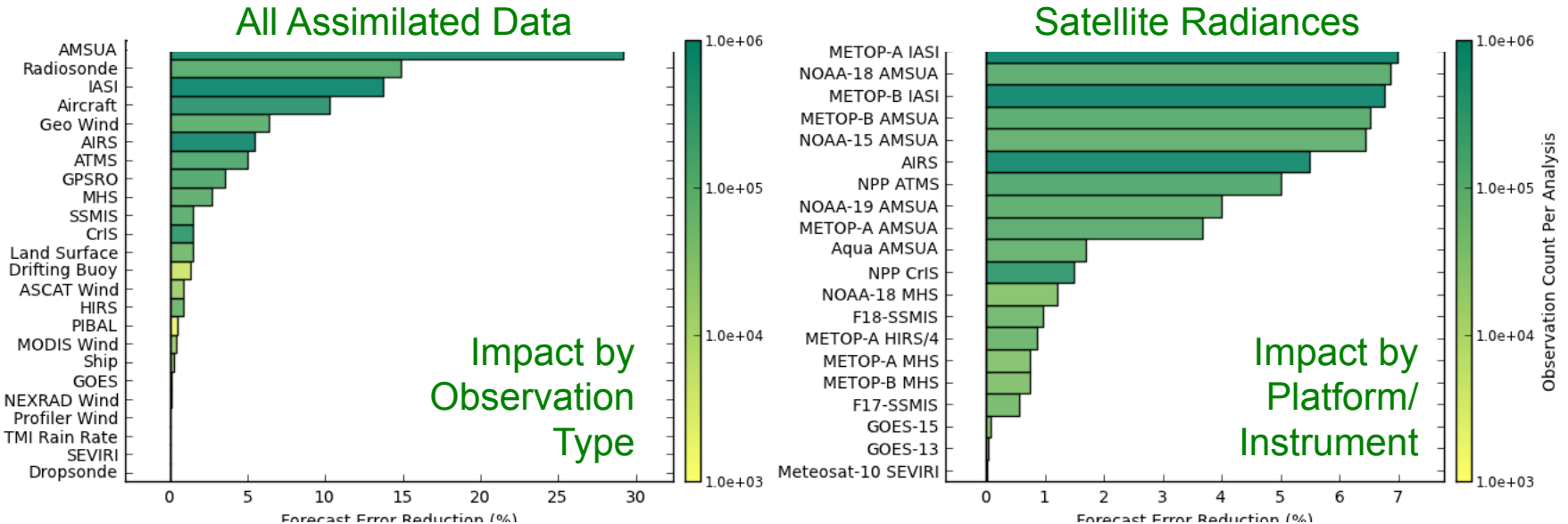
GMAO Themes



- These (non-orthogonal) themes span GMAO's main focus areas
- Strong emphasis on NASA's Earth Observations (use, support, planning)
- GEOS-5 research uses the same systems as used for product generation
- GEOS-5 is a modular system, encompassing many Earth System components

Observing System Impacts in NWP

GMAO has developed adjoint-based sensitivity diagnostics that isolate the impact of all observation types. These are now released as part of GMAO's product suite.



Results for July-August 2014, including the GPSRO, Suomi-NPP (ATMS and CrIS), and MetOp-A and B (IASI, AMSU-A, MHS) radiances. The fractional impact on 24-hour forecast error reduction is shown.

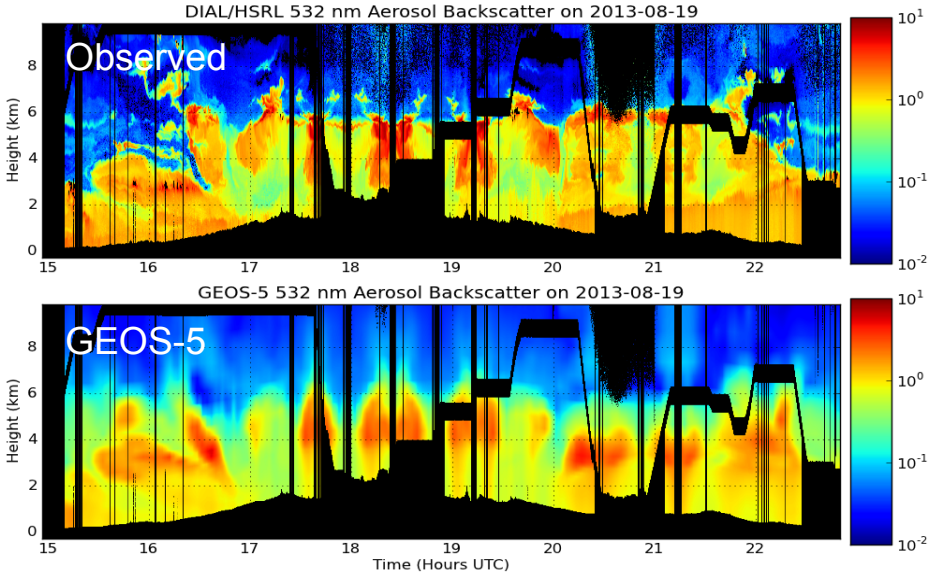
- Impacts of all observations on weather prediction (above)
- Studies of the impact of new observation types (OSSEs)

Field missions: from Aerosols to Ice!

GEOS-5 analyses & forecasts:
- Meteorology
- Aerosols & SO_2
- CO & O_3

Constituents included in GEOS systems since 2004:
- Intex-NA (2004): simple C
- Now: CO, aerosols, etc.
- Future: reactive chemistry?

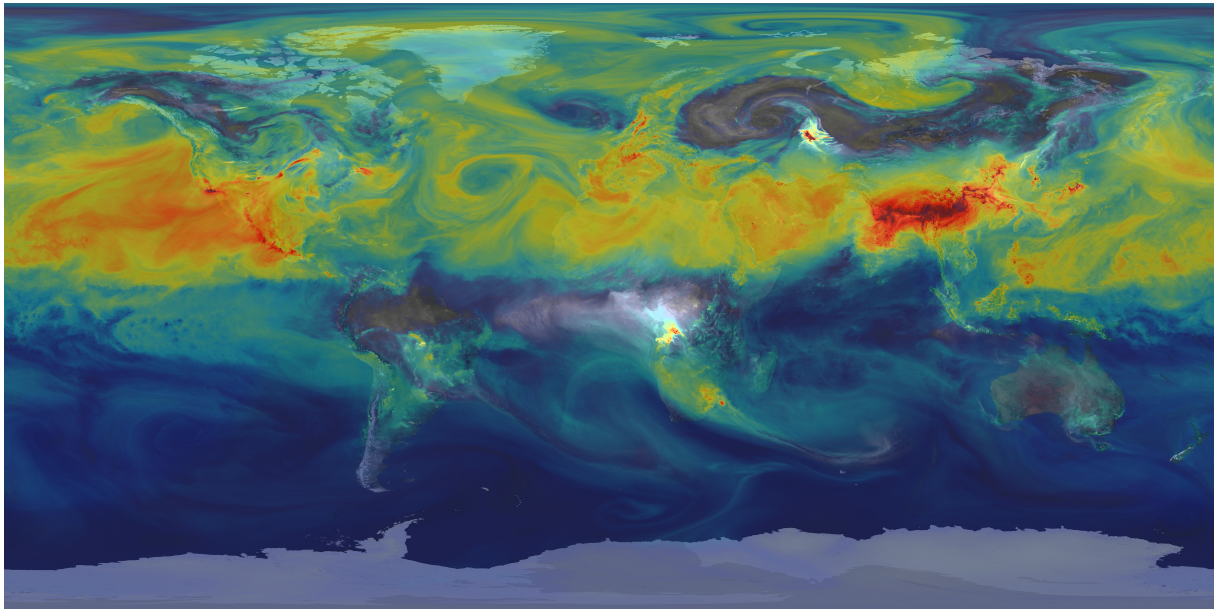
Contributions to many recent missions: TC4, ARCTAS, GloPac, ATTREX, DISCOVER-AQ, HS3, …



Observed (top) and simulated (bottom) aerosol backscatter (532 nm) along the flight track on August 19, 2013, during NASA's SEAC^{4}RS field campaign.

- GMAO has contributed to many NASA (and other) field missions
- Especially atmospheric composition
- Recent participation in ARISE and also IceBridge
- Form a basis for focused process improvement in GEOS-5

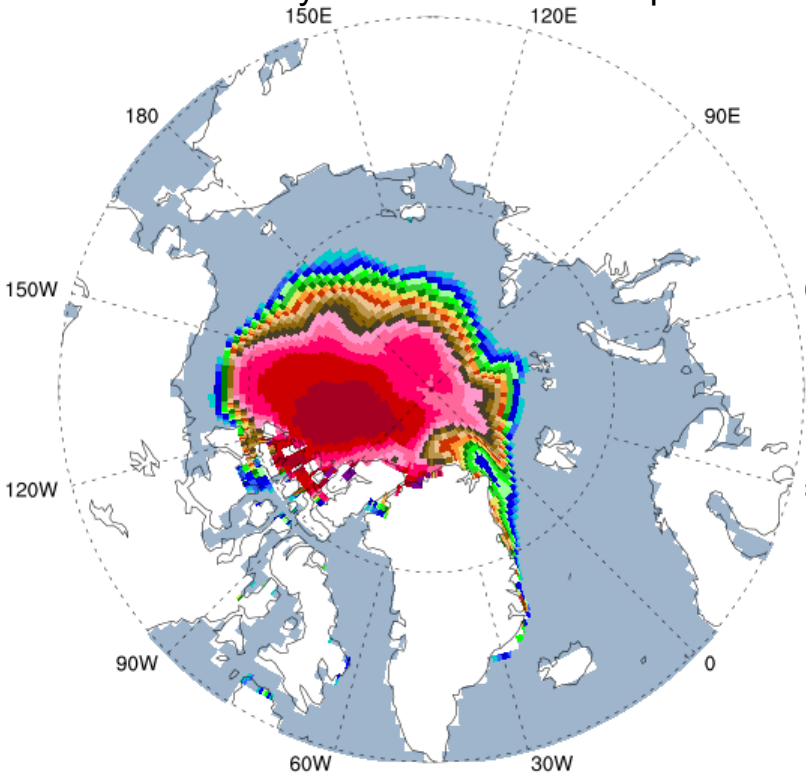
Global CO_2 field from the 7km-G5NR (June 21, 2006)



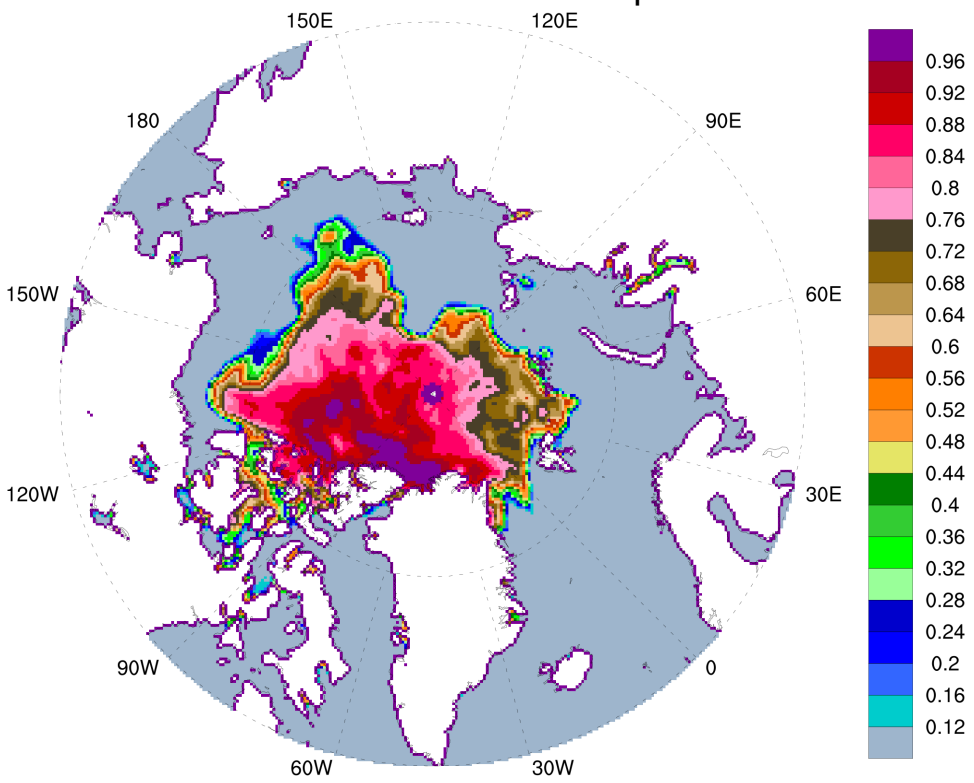
- Demonstrates fidelity for constituent simulation alongside meteorology
- Opens pathways towards non-meteorological OSSEs, including studies for active CO_2 sensors
- Pathway towards high-resolution air-quality modeling (GEOS-Chem)

Sea Ice Prediction from Seasonal Forecasts

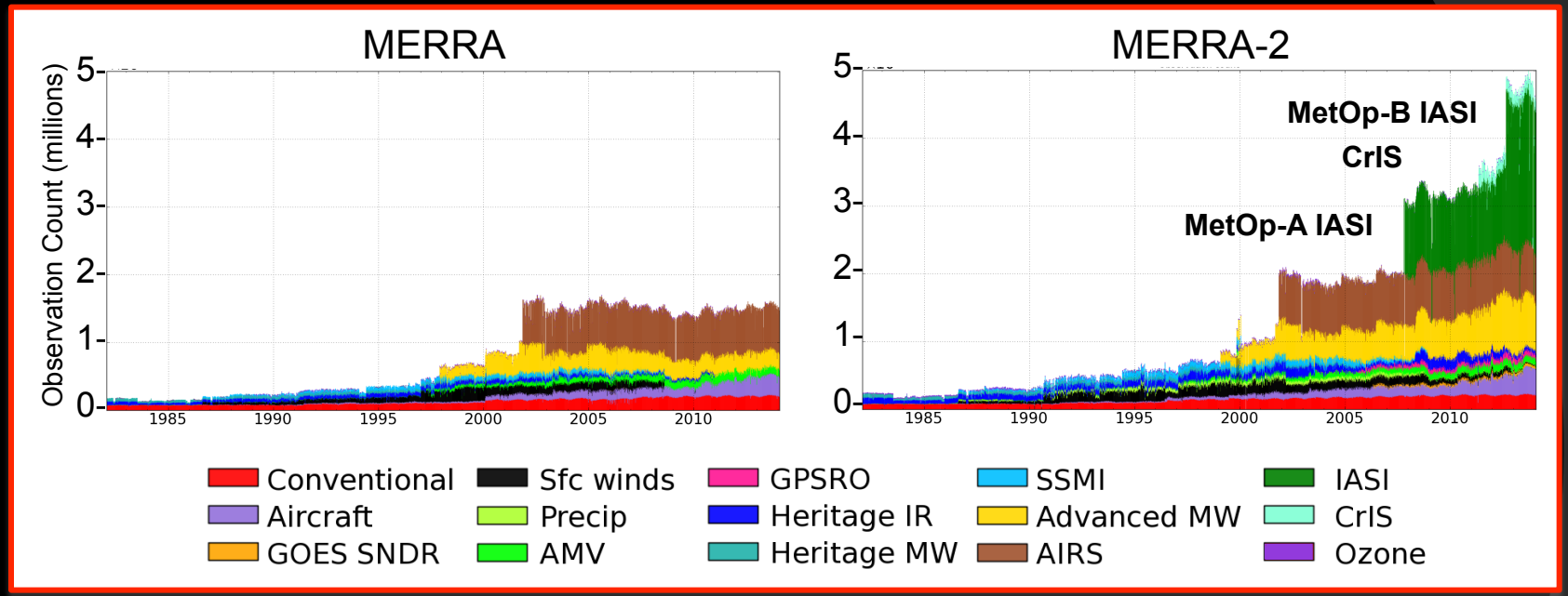
GEOS-5 Mid-May Ensemble: Valid September 2014



GSFC SSMIS – DMSP-F17 September 2014

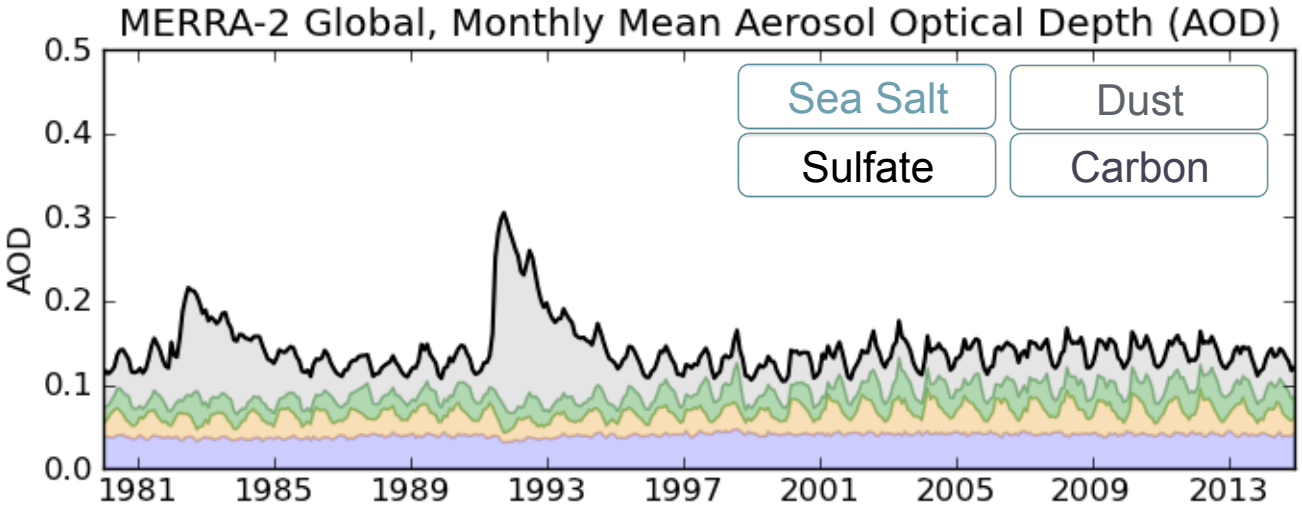


MERRA-2: Observing System Time Series



MERRA-2 assimilates modern satellite observations not usable in MERRA. The number of observations in each 6-hr assimilation cycle now approaches five million, as additional hyperspectral sensors such as IASI and CrIS have become active. In contrast, MERRA includes no satellite radiance data types that began operations after 2005. Its data count would drop dramatically if Aqua were to fail.

MERRA-2: on the Path to Earth System Reanalysis



As well as using new meteorological data types and an updated GEOS-5 system, MERRA-2:

- Includes a coupled aerosol analysis
- Has a more realistic middle atmosphere
- Improves the representation of polar climate

A few issues that have arisen with MERRA-2

- Upper tropospheric moisture: high bias (almost certainly originates from the GEOS-5 model)
- Long-term changes in T_{2m} do not show increasing trend in recent years (complex issue under investigation)
- Global radiation balance is less good than it was in MERRA, although some components are improved

Support for CERES Science Team

- GEOS-5.2 System:
  - Based on MERRA (2008 vintage)
  - Turned off in February 2015 (computing system)
- GEOS-5.4 System:
  - Slightly newer system (2010 vintage)
  - Committed to running this for CERES
- GEOS-5.12 System:
  - Based on MERRA-2 (2015 vintage)
  - Studies related to Observing System (no hyperspectral IR)

Planned Support for CERES Science Team

- GEOS-5.4 System:
  - Committed to running this for current CERES processing algorithm
- GEOS-5.12 (MERRA-2) System:
  - Is this system useful for CERES (e.g., moisture bias)
  - What do we learn from this system?
- GEOS-5.xx System:
  - When does CERES need a “frozen” configuration?
  - What are requirements (resolution, configuration, …)?
  - How can we communicate effectively?